STUDIES UPON INJURIES OF THE KIDNEY, NEPHROLITHOTOMY AND NEPHRORRAPHY.

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IN THE preface of this paper the author wishes to state that the succeeding lines are intended as an additional contribution, rather than a complete study upon the momentous subjects indicated in its title.

At the outset I wish to acknowledge my obligations to Dr. B. H. Lammers, Dr. Eiseman (D. V. S.), Mr. Joseph Coomes, and others, for their invaluable assistance which has been freely given me in my work.

In this contribution it has been my endeavor to add to our knowledge concerning these affections with the hope of increasing the chances of saving this organ in conditions which formerly might have demanded its removal.

The import of this necessity is most keenly felt, when we remember their significance as the most important emunctories in the human economy.

While life itself may continue apparently unaffected after the loss of a kidney, it nevertheless seems within the pale of logic to regard such a loss as proportionally increasing the chances of future difficulty from over-taxation, not to speak of the gravity which would attend the presence of a condition demanding surgical interference upon the remaining organ.

It is frequently a difficult matter to draw a hard line between the relative bearing which the physician and the surgeon have toward many of the pathological processes of this organ, to decide when and which are medical or surgical cases.

The text of this article is based upon an analysis of the present literature upon the subject, together with a few observations drawn from the post-mortem table and a moderate amount of experimental investigation.

It was my intention to have dwelt upon nephrolithotomy and nephrorrhaphy as thoroughly as upon the injuries of the kidney but time and space defeated this end.

This is all the more to be regretted since certain sections, especially upon nephrolithotomy, are perhaps of the greatest moment to the surgeon.

The original intent was not only altered in this respect, but it became necessary for the same reason to at least temporarily abandon a series of experiments embodying some possible improvements upon a subject closely related to the one under consideration.

In carrying out these experimental operations due regard was attached to cleanliness. The operative field was thoroughly scrubbed with soap and warm water and finally irrigated with a sublimate (1x1500) or a carbolized solution.

Throughout the operation the neighboring space was carefully protected with towels wrung from a warm sublimate solution.

Where irrigation was resorted to within the cavity, either warm Thiersch's solution or boiled water was employed. The animals were selected irrespective of their size or condition and submitted to no preliminary preparation other than anæsthetization.

For the latter purpose both ether and chloroform were employed. The former was invariably employed to commence the anæsthesia, which was afterward continued with chloroform cautiously administered.

The animals were fed upon finely chopped meat or upon milk. However slight the operation may have been, they ate little or nothing, as a rule, upon the following day.

Unless otherwise indicated, the kidneys were exposed through an incision made into the loin commencing immediately below the ribs, running parallel with and a short distance from the spine. While such an incision afforded an admirable access to the kidney, it was nevertheless far from being as desirable as one in the linea alba, since the peculiar position of the subject, at best afforded a miserable provision for drainage, and was in a few instances the cause of infecting the interior.

The incisions were closed by a double row of sutures, inverting the flaps at the lower angle as a provisional step toward securing drainage. The union in all but two instances was by slow granulation.

In the excepted cases primary union was obtained. As for suture material, silk, prepared after the precepts of Czerny, was generally employed for internal work. For closing the entrance wound linen thread (Marshal's) properly disinfected was exclusively used. In addition to the silk, catgut of different sizes and variously prepared was also experimented with. The ordinary catgut, duly sterilized, was generally absorbed too rapidly in renal tissue to be considered a safe material unless an extra large size was selected.

Experiments were made with the view of retarding its absorption as well as endowing it with hæmostatic properties. In the beginning the gut was allowed to remain for several days, immersed in the ordinary tincture of Ferric chloride under the impression that the time of maceration would bear a direct ratio to the necessary time required for its absorption. If, however, the maceration was continued too long the gut became soft and useless. In lieu of this, immersion just before its employment was then attempted. When this was employed the gut in a few instances was dipped in alcohol just before its use, while in others it was used just from the iron solution. Besides the tincture, Monsel's solution pure and a mixture of equal parts of Monsel's solution and water were substituted. The endeavor to obtain a hæmostatic suture material was prompted by the hæmorrhage which was at times occasioned by the introduction of a stitch which perforated a small arteriole.

Although the immersion of the gut in the iron sensibly retarded its absorption without any evil effect upon the kidney itself, yet its hæmostatic property which it thus acquired seemed rather slight.

Whenever the sutures passed clear of a vessel there was practically no hæmorrhage.

If, however, they perforated an arteriole, especially if superficial, a rather troublesome oozing arose.

The ferrated gut in a number of instances arrested this oozing, but it also failed quite a number of times. Generally, such oozing was controlled by a few stitches introduced in such a manner as to constrict the structures around the opening.

The experiments are arranged according to their nature and variety rather than their chronological order of performance. An unsuccessful attempt was made to collect the urine with the view of establishing certain practical diagnostic points in the injury of these organs, but the unmanageable nature of the subjects rendered this impossible. The importance of conservative steps in certain selected cases of these injuries cannot be too strongly emphasized.

The value of a kidney that has been subjected to an operation for an injury and again recovered has been amply tested in these experiments by the removal of its uninjured fellow. In fact, the question as to the amount of renal parenchyma necessary to sustain life has already been the subject of considerable attention.

Tuffier,[1] who has conducted a series of experimental operations upon the commoner surgical procedures upon the kidney, has arrived at the following conclusions:

Almost complete cessation of the excretion of urine and urea followed every nephrectomy, lasting however never longer than twenty-four hours. The suppression of urine is supposed to be of a reflex nature.

This author is of the opinion that approximatively 1.0 to 1.5 grammes of secreting renal parenchyma is required per kilogram of the animal, and, reasoning from this concludes that for an average person of about 70 kilograms 80 to 100 grammes of renal structure are necessary, or one-third or one-fourth of the total amount. The death of the animals which were subjected to a series of nephrectemies occurred in from twenty-four to thirty-six hours but was not attributed to a uremia, but rather to a variety of profound collapse simulating a traumatic shock. The remaining part was credited according to the urine in the bladder, with continuing its function, compensation occurring partly from actual hypertrophy of the renal parenchyma and partly by the new formation of glomeruli.

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[1] ANNALS OF SURGERY, October, 1890.

While many of the questions touching upon this interesting subject may yet be impossible to decide, it seems that the resulting effect of a partial or complete nephrectomy is largely dependent upon the condition of the remaining structure. This was evidenced in Experiment 12, in which nephrectomy was practiced.

The remaining kidney, which presented unmistakable evidence of a parenchymatous degeneration, rapidly proved insufficient. While one-third or one-fourth of the secreting portion of the kidney may sustain life for a time being, yet such a diminished amount can hardly be expected to fulfill the natural demands for any length of time without breaking down from over-taxation to which it would necessarily be subjected.

The largest amount of secreting structure removed in these experiments was about one-third the total amount of a single kidney. The animal lived several months after the removal of the opposite kidney, during the whole of which it presented a broken down appearance, dependent in a measure apparently upon a toxæmia consequent to an insufficient renal action.

At times all appetite would be lost and the general appearance was that of a very drowsy condition.

At the post-mortem examination an abscess was discovered above the kidney, in connection with the supra-renal capsule together with a small abscess within the spleen.

There can hardly be a margin wide enough for the belief that death was entirely dependent upon the abscess external to the kidney.

The kidney frequently diminished considerably in size after being subjected to an operation even where this consisted of a simple exploratory incision.

The remaining secreting element of the kidney, however, usually underwent a compensatory hypertrophy.

Death is said to occur in from one to three days after the complete removal of both kidneys. In Experiment 13, this was carried out, the animal survived the removal of the second kidney four days. During the whole of this time no outward symptoms were perceptible other than a drowsy condition.

In many of the experiments the efficacy of the recovered kidney was tested by the removal of the other organ. The only instance in which the recovered kidney seemed insufficient was in the twelfth experiment. In this the imperfect elimination of toxic refuse was very evident.

The presence of sepsis was recognized by an elevated temperature of from one to two and a half degrees, loss of appetite, diarrhœa, great thirst and a peculiar drowsy appearance.

In studying the effects of gunshot wounds a .22 ball was employed which with the kidney of a dog practically produced the same effect as that of a .32 or .38 in the human subject.

A microscopical examination of a kidney that had then subjected to a gunshot injury revealed a firm union, composed of cicatricial tissue which was surrounded by the renal structure bearing evidence of considerable contraction from the development of cicatricial tissue.

This compressed condition gradually merged into the healthy renal structure.

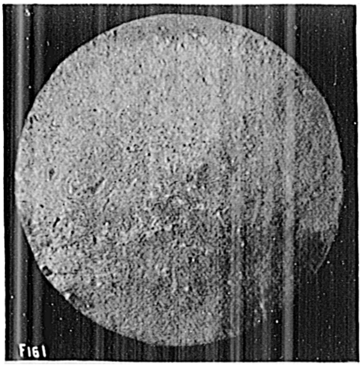
Where the compression was greatest the tubes were almost or even completely obliterated and the glomeruli very much contracted in size.

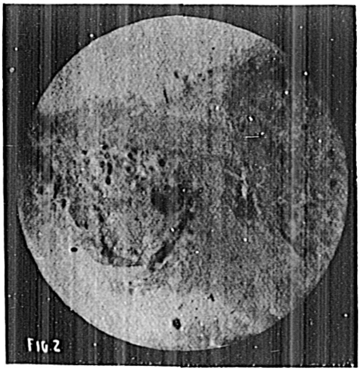
Parenchymatous degeneration of the cortex and a decided thickening of the capsule were distinctly evident.

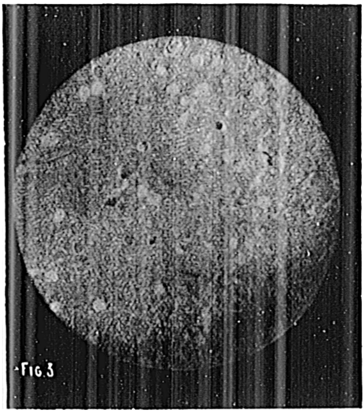
INJURIES OF THE KIDNEYS.

Classification.—It seems that most authors in classifying the lesions to which the kidneys are liable, draw the line between those attended with a wound in the abdominal wall and those in which the latter is intact, considering under the first heading such injuries as contusions and lacerations, while for the latter is reserved the shot and stab injuries.

However, since the subparietal injuries are by far the most common, and when a wound in the wall does exist it is perhaps better to regard it rather as a complication, just as a renal injury may become a complication to another and more serious injury within the abdominal cavity, a simpler and possibly bet-







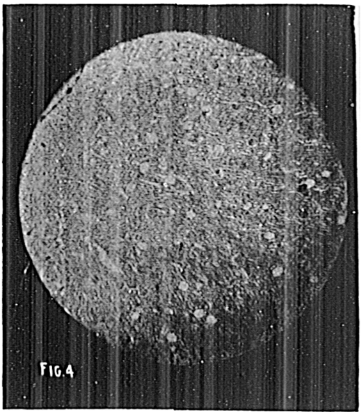


FIG. 1.—Microscopic section of a wounded kidney through cicatricial tissue.
FIG 2.—Microscopic section of wounded kidney showing relation of true and cicatrical tissue.
FIG. 3.—Microscopic section of normal kidney of a dog.
FIG. 4.—Microscopic section of a kidney that had been subjected to an implantation.

ter arrangement would be into injuries of the kidney proper and injuries of its excretory duct, considering under the first heading contusions with or without rupture of the capsule and kidney structure, laceration, shot and stab injuries. Although the duct of the kidney may be injured in as many ways as the kidney itself, yet their size and more protected position makes their injury an infinitely rarer occurrence. As for the frequency with which the kidneys are injured and the abdominal wall left intact, Mr. Morris[1] remarks, that "out of two thousand six hundred and ten inspections of persons dying of all kinds of injuries and diseases there were thirteen of injured kidney, twelve of which were sub-parietal and one a penetrating wound."

Causation.—Apart from shot and stab injuries, a host of other influences contribute in determining the production of renal lesions. Among which we might repeat the well known buffer accidents, or the crushing of the trunk in a like manner between two opposing bodies, the passage of a wheel over the body in the lumbar region, direct blows upon the abdomen in the form of kicks, falling bodies, the explosion of shells, etc., falling from a height and striking against another object, the acute bending of the body and a variety of rarer accidents that occasionally likewise bring about these injuries.

Pathology.—Although the remote position of the kidneys frequently renders difficult the exact appreciation of traumatisms of these organs, it nevertheless fails in protecting them entirely from any variety of injury to which a more exposed member is liable. Those who have closely searched the kidneys upon the post-mortem table it will be needless to remind of the frequency with which palpable signs of former injuries are found, and those who have sharply studied the cases which the literature affords have, no doubt, been struck with the extreme degree of the lesions upon one hand, and oftener, by the disproportion between the cause and the effect and course of the lesion upon the other. To realize and appreciate this peculiarity, it is necessary to carefully remember their anatomical structure, their physiological function, and the frequency with which these organs are found in a condition different from that of the healthy state. At best, its lacerable nature, its unremitting function as an emunctory and the oft congested and inflamed conditions must each lend their influence in determining the degree of the injury and shaping the character of its termination. Contusions and lacerations are the commonest varieties of injury to which these organs are liable. They may vary from the simplest lesion to an extensive laceration and destruction of the kidney. In fact, unless the contusion is singularly slight, it is generally associated with more or less rupture of the capsule or kidney structure.

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[1] Diseases of the Kidney. Henry Morris, F.R.C.S.

The kidneys may also be lacerated to any degree. Otis mentions a case in which the kidney was lacerated through its entire long axis, death ensuing from hæmorrhage. Again, the kidney may be ruptured throughout in any direction, in which event death as a rule rapidly ensues from hæmorrhage. The rupture may be confined either to the anterior or posterior surface. In the former instance the extravasation of blood and urine occurs into the peritoneal cavity while in the latter extravasations of the same fluids are confined to the circumrenal tissues.

They may or may not be characterized with external evidences of an injury. This, however, offers no criterion as to the amount of the internal danger. Frequently, slight internal lesions are attended with extensive ecchymosis and evidences of considerable injury to the external surface, and on the other hand there may be little or no external sign to denote an extensive internal injury. Of this the two succeeding cases are fair examples:[1]

"A gentleman, whilst hunting, received a bruise over the left loin and on arriving home experienced a severe pain in the back. After a very judicious treatment of several weeks the bladder finally became irritable, the urine highly offensive and mixed with pus.

The pus increased, the health becoming deteriorated and death ensued after a lapse of about two years subsequent to the accident. The left kidney was entirely destroyed, and in its structures was found a large irregular abcesss with its walls adherent to the surrounding soft tissues and its cavity continuous with the ureter."

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[1] Holmes' System of Surgery, Vol. 1, Page 8.

"A boy was struck over and rather in front of the right lumbar region by the handle of a truck. He immediately fell and though able to rise and walk a few steps he again fell, and was then carried to Guy's Hospital. He was in a state of extreme collapse with some pains in the abdomen. He died within an hour and a half of the accident. Externally, there was a slight ecchymosis over the extremities of the seventh and eighth ribs on the right side and the last two ribs on the left side. The cavity of the peritoneum contained a large quantity of coagulated and fluid blood. All that portion of the left kidney above the entrance of the vessels was torn from the lower portion and separated from the natural surrounding attachments. The lower portion was undisturbed. There was some ecchymosis on the surface of the liver opposite to that on the chest."

In addition to these another instance which came under the observation of the writer is mentioned further on, under the prognosis of these injuries. The wound in the abdominal wall may be of such an extent as to expose the kidney, or the exposed organ is occasionally found within the abdominal wound, or even lying completely outside of the body.

This, however, is most likely to happen where the abdominal wound is very large, and the kidney more or less movable. The hæmorrhage from renal injuries is variable, and when it occurs the clot may accommodate itself in several ways. In subcapsular lacerations, for instance, it is confined to within the limits of the kidney. Where, however, the laceration is somewhat extensive and anteriorly, the blood passes into the perirenal structures, and almost necessarily into the general peritoneal cavity. If the laceration is posteriorly the hæmatoma is found within the structures surrounding the kidney. The blood thus extravasated may become absorbed, or it may break down and suppurate, forming a nephritic or perinephritic abscess, or even give rise to a pyonephrosis. Mr. Morris, in his excellent work upon this subject, mentions a case in·

which the blood remained unabsorbed—"A man who died eighteen months after the reception of a kick from a horse. Both kidneys were granular and full of cysts. The cellular tissue around the right kidney was consolidated, a large clot of blood occupying its pelvis and interior and communicated also with the exterior, where a large quantity of blood clot was lying in the subperitoneal tissue. The line of rupture could be faintly traced through the substance of the gland. The ureter was cut across about one and a half inches from the pelvis and was quite impervious."

It has also been pointed out by the same author that there may be an extensive effusion of blood into the cellular tissue around the kidney, with but little evidences of injury to the kidney itself, or, on the other hand, the kidney may "well nigh be converted to a pulp" directly from an injury, or secondarily, as the result of an injury with little or no extravasation into the surrounding structures.

Experimentally, it was observed that when the kidney was contused ecchymosis rapidly ensued, the kidney assumed a dark bluish appearance, increased in size directly in accordance with the amount of contusion, and if severe became fluctuant to the touch. This effusion may become absorbed after the same fashion as in contusions elsewhere, and no palpable sign of a former injury remain, or it may be marked by a depressed and contracted scar which represents the former injury, or, as it not infrequently happens, it may give rise to a nephritis, a nephritic abscess, a pyonephrosis, or a pyelitis.

Gunshot injuries of the kidneys are by no means rare accidents in cases of penetrating wounds of the abdomen. Otis,[1] out of 1072 cases of shot injuries within the abdominal cavity records 78 cases of shot injuries of the kidney. However, where there is a shot injury of the kidney, one or more of the other abdominal organs are almost inevitably wounded. Perhaps the intestine more than any other viscera complicates the renal injury. Hæmorrhage in these cases is usually large, and frequently determines a lethal ending.

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[1] Med. and Surg. Hist. of War of Rebellion, 2d Surg. Vol.

The blood alone may find its way into the circumrenal structures or into the peritoneal cavity. Where the injury involves the pelvis the extravasation is mixed with urine. The kidney may be injured through a missile in any direction, and to almost any degree, from a simple perforation to a perforation with the loss of a considerable portion of the kidney structure, or even to a shattering of the entire organ. The relative effects of the different varieties and sizes of balls has been a matter of considerable conjecture, discussion and experimentation. It can be safely stated that, as a rule, the size of the wound is in proportion to the size of the missile. However, this has many exceptions, and these exceptional effects have been attributed to a variety of influences.

The size being the same, the effect is very much moulded by its force and velocity, the character of weapon and the peculiarity of the ball. A ball traveling under diminished force is more apt to produce a lacerated puncture than one moving with great force and velocity, which generally produces a clean perforation with little or no laceration, and an almost inappreciable loss of structure.

A ball fired from a rifle created, as a rule, a greater injury than the same sized ball fired from a pistol. A difference in severity existed between a "long" and a "short" shell, the difference being in behalf of the "long." A Flobert was irregularly trimmed with a knife and thus fired. This was repeated several times, and in each instance the injury was largely in excess to that of one produced by a smooth ball. In a few the injury thus created was comparable with that of one produced by a .32 or .38 ball. The charges in shells of the same class are also frequently of very different propulsive power, which tends to control the force and velocity of the missile.

Repair under the proper conditions is frequently obtained, and where this results the track of the ball contracts and a small column of cicatricial structure completes the defect. If there is a loss of the renal structure and the same result occurs the site of injury is usually marked with a depressed scar. Finally, the kidney proper may also be injured through stabs by means of a knife, or other pointed instruments, or as in military practice, through bayonet punctures.

Notwithstanding the size and its protected position, we have, nevertheless, a few authenticated cases of injury of the ureter. Of these we may mention the cases of Barker,[1] Stanley,[2] Poland,[3] and the much quoted case of the Archbishop of Paris, as examples of these injuries. This duct has been injured in various ways, directly through a shot injury, as in the case of the Archbishop, or through a contusion, as in Mr. Barker's case, and several times it has been directly injured in abdominal and obstetrical operations. Mr. Newman remarks that injury to the pelvis of the kidney without penetration of the abdominal wall is as rare as rupture of the ureter. It has been observed that soon after a rupture of a ureter, a pseudo-hydronephrosis has ensued, from infiltration of the urine into the surrounding structures. Resulting from an injury, the ureter may undergo contraction, producing a stricture which subsequently causes a hydronephrosis, destroying the organ and necessitating its removal. An instance of this is recorded by Dr. Pye Smith[4] in which a large hydronephrosis of the left kidney was produced from a kick received two years previously, and similar cases are mentioned by Mr. Croft and Dr. Harrison.

Symptomatology.—The symptoms referable to lesions of the renal organs can be divided into those relative to the constitution at large and those of a local nature. The constitutional symptoms consist of a rapid, feeble pulse, lowering of the bodily temperature, pallor, nausea, vomiting, muscular relaxation and in short the typical signs of collapse. The degree of collapse, however, in these, as in other instances, of injuries about the abdomen does not always correspond with the amount of the injury. There may be a severe injury, with little

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[1] A. E. Barker, Dict. Pract. Surg. Heath. Vol., I., page 864.

[2] Royal Med. Chir. Trans., Vol. XXVII.

[3] Guy's Hosp. Reports, 3d Series

[4] Newman on Diseases of the Kidney Amenable to Surgical Treatment. Page 326.

tle or no evidence of shock, or vice-versa. The emotion and other influences frequently play an important rôle in determining the degree of shock. In view of the vascularity and the liberal nerve supply, injuries of these organs are peculiarly liable to be followed by severe shock. Again, the shock is not always entirely dependent upon renal injury, *per se*, for in a large number of instances there is more or less injury to the other organs, which renders the analysis of cause and effect in many of these cases difficult. In those that are attended with a breach in the kidney structure, the amount of hæmorrhage is frequently sufficient to materially augment the constitutional symptoms. Occasionally, the condition of collapse gives way to that of a comatose state, which speedily ends in dissolution, or later, when the collapse has passed off, the symptoms of peritonitis make their appearance.

Soon after the reaction is fairly inaugurated, the local symptoms, which were hitherto largely masked by the constitutional depression, become more evident. Notable among these we have hæmaturia, pain, repeated attempts at micturition, or even anuria, muscular rigidity, fullness in the loin and the appearance of urine at the external wound.

Hæmaturia is, perhaps, the commonest and most important symptom of a renal injury. Its absence, however, is by no means a certainty of their escape, nor is its appearance an absolute sign of their involvement. Even in injuries about the lumbar regions we must not be misled by this symptom. Illustrative of this point, Mr. Newman records an excellent example.

"A boy fell from a distance of twelve feet and alighted on his side, which struck violently against the edge of a packing box. Was picked up suffering from an ecchymosis over the right eye and over the left lumbar region. The boy regained consciousness, complaining only of symptoms about the head, the hæmaturia in the meantime continuing. Minute inquiry elicited the fact that red urine had been passed previous to the injury. The boy passed on to recovery and subsequent examination proved the presence of a small papilloma in the bladder from which blood continued to flow at irregular intervals."

A variety of causes may contribute in creating the appearance of blood in the urine. In an analysis of one hundred cases, Mr. Harrison[1] found thirty dependent upon renal calculi, twenty upon enlarged prostate, thirteen upon tumors mostly malignant, fourteen upon vesical calculi, two upon traumatism and the rest divided up principally among tubercle, stricture, cystitis and a variety of other causes.

When hæmaturia occurs, it may make its appearance in from a few minutes to a few days after the reception of the injury. It may be slight, amounting to only a darkening of the urine, or, again, it may be profuse and attended with clots. The clots may assume the shape of the uriniferous tubules, the ureter or may accumulate within the bladder, causing a distention of this organ.

The absence of hæmaturia in an injury of the kidney may occur in various ways. The injury may be confined to the subcortical portion of the kidney, in which event the blood in place of finding its way into the urine is extravasated into the surrounding structures. Again, the organ may be injured to such an extent as to completely arrest its secretion. The secretion may also be arrested from the formation of a thrombus in the renal vessels. Erichsen[2] mentions two cases in which the absence of the hæmaturia was due to an arrest of the secretion dependent upon an extensive injury of the kidney, both cases ending fatally. Aside from these, the absence of hæmaturia may also be dependent upon a division of the ureter or the obstruction of its lumen.

The arrest of a clot within the ureter may determine a delay of this symptom and give rise to another condition resembling a renal colic.

Soon after the hæmaturia ceases, the urine may become albuminous which may last for some time and be associated with the presence of blood corpuscles, pus, mucus, renal epithelium, or casts, clearly denoting a subsequent inflammation of this organ.

Pain is another common attendant upon a renal injury. This is generally of a dull, aching character, increased with the respiratory movements. The pain, which may be variable in degree and at its onset confined to the lumbar region, soon spreads through the lumbar and sympathetic nerves to the other parts of the abdomen, to the testicles and to the upper part of the thigh. Frequently this is marked by a retraction of the testicle. When the lumen of the ureter becomes clogged, as from a clot, the pain becomes intense and very much resembles that of a renal colic.

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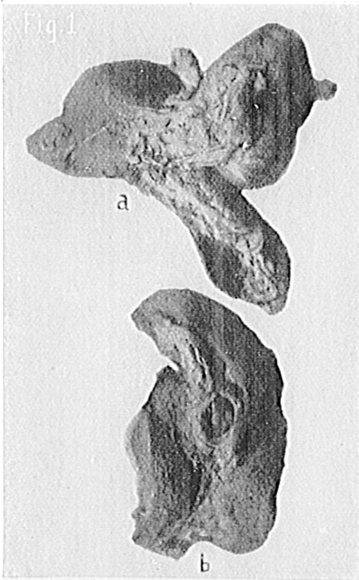
[1] Reginald Harrison, Times and Register, Aug. 9, 1890.

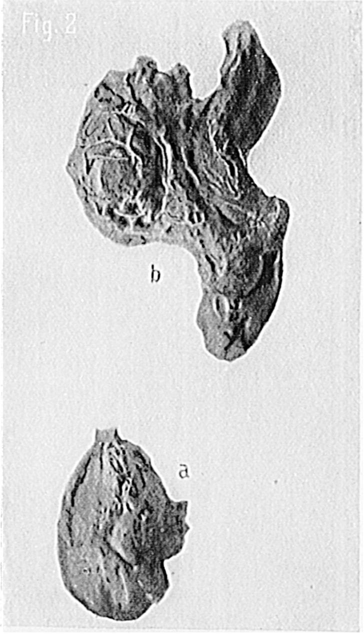
Fullness in the loin is frequently observed in injuries of the kidney. This fullness, for it seldom amounts to a distinct swelling, may be due to the injury of the abdominal wall alone or it may be due to the injury together with the extravasation of blood and urine, or even both into the surrounding structures. Later on, however, this fullness may be replaced by a distinct swelling, dependent upon the formation of a hydronephrosis, pyonephrosis, perinephritic abscess, or even a urinary cyst. Difficult micturition, or even complete anuria is not uncommonly met with in renal lesions, the complete absence of urine may be dependent upon the formation of thrombi within the renal vessels, upon an injury involving both kidneys, or an impaction of blood clot in the orifice of the urethra or neck of the bladder or an inhibitory nervous influence. In Mr. Poland's case[1], the almost complete absence which persisted for the last six days of the patient's life was dependent upon a thrombus in the vessel of one kidney and the laceration and extravasation of urine in the other.

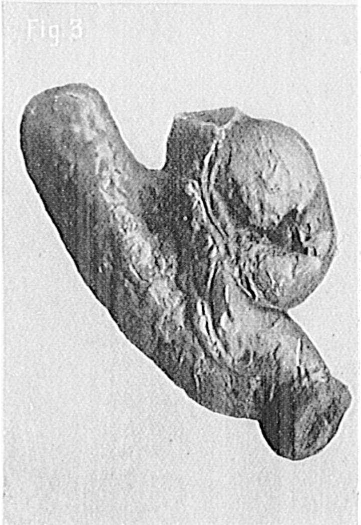
Another common attendant upon renal injuries, is a spasmodic contraction or rigidity of the abdominal muscles.

Lastly we have as a symptom of renal injury the escape of urine at the external wound. This symptom, however, is not a common one and when it occurs is indicative of an injury of the pelvis or ureter. The escape of urine externally may occur soon after the injury, or it may be delayed for several days or even for a week or more; and, when this does occur it furnishes the only absolute sign of an injury of the kidney.

Diagnosis.—The remote position of the kidney, its close proximity to the neighboring organs, and its intimate sympa-







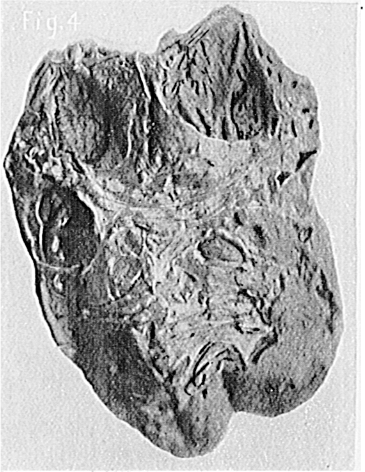


FIG. 1. (A)—Showing the result of a lateral resection of the kidney, with splenic adhesion.
(B)—Small abcess cavity in spleen
FIG. 2. (A)—Result of longitudinal resection of a portion of kidney.
(B)—Incomplete union occasioned by peri-nephritic suppuration resulting from an infection through the external wound.
FIG. 3.—Showing imperfect union from premature absorption of catgut stitches.
FIG. 4.—Interior of abcess cavity in the upper portion of a kidney and supra-renal capsule.

thetic connections all serve to obscure the outlines and render difficult the diagnosis of a renal complication in injuries of the abdomen.

The only symptom indicative of absolute injury is the escape of urine, externally, and, since this only occurs in the fewest number of cases, penetrating wounds which form the lesser half of renal injuries and not even in all of these, we can easily appreciate the difficulty which frequently befalls the surgeon in their detection.

Apart from the above, hæmaturia is perhaps the most constant and valuable symptom occurring in these cases.

Following these we have pain, interference with micturition, rigidity of the abdominal muscles and a fulness in the flanks. If, there is a history of a direct or indirect injury to the abdomen, coupled with more or less constitutional impression and the subsequent appearance of hæmaturia, pain, muscular rigidity, difficult micturition, all of which lasting for a considerable time and marked with a tardy convalescence, sufficient grounds for the inference of a severe contusion or laceration are at hand.

Too much importance, however, must not be attached to any of these symptoms. Where the injury is of a trivial nature, the symptoms are frequently of such an indefinite character that an exact diagnosis is impossible. The diagnosis of a renal injury in penetrating wounds is not fraught with the same amount of difficulty that attends those of a sub-parietal nature. Although in shot injuries of the abdomen the damage is generally distributed over a number of the abdominal organs we are confronted with a more suggestive clinical picture as regards the renal injury.

In addition, experience has amply taught us the importance of the rule as regards the necessity of an early exploratory incision, in penetrating wounds for the thorough inspection and repair of the existing damage. The peculiar nature, the manner of their reception and the topographical relation all aid in rendering the diagnosis of stab' injuries of this organ comparatively easy. It is very fortunate that an injury of the pelvis or ureter is of a rare occurrence, since the diagnosis of such a lesion is by no means of simple performance.

In the few recorded cases the principal points of note were "the absence of severe shock, the appearance of two worm-like clots and the formation of a fluctuating tumor;" or, if the injury is of the penetrating variety there may be an escape of urine externally.

Prognosis.—From the foregoing remarks under the pathology and symptomatology of these injuries it is hardly necessary to repeat, that in view of the uncertainty which surrounds these injuries, the prognosis must need be very careful. While wounds of the kidney heal very readily, and while the outgrowth naturally depends upon the amount of the injury, it remains that frequently, apparently trivial injuries give rise to unfavorable consequences which not uncommonly end in a fatal termination. One of such was observed by the writer in a recent autopsy.

The case was that of an elderly man of perhaps 55 years of age, whose occupation was that of a hostler in a large stable, which work frequently exposed him to kicks from the animals. On New Year's day he was subjected to one of such accidents. Upon this occasion he received an injury of the right leg, and at the same time one in the lumbar region. From this he suffered considerable inconvenience, but was able to make his way to his home some distance off. After a rest of a few days he again attempted to resume his work. In this partly disabled condition he continued to work more or less, feeling at times comparatively easy. On the 17th of the same month he suddenly grew worse and after suffering for a few hours, expired.

At the post-mortem no external signs of violence were visible, save that of a very slight discoloration about the knee and a marked œdematous condition of the entire leg below this point. The heart was slightly dilated and in addition there were evidences of a chronic bronchitis and some marginal emphysema. General pleuritic adhesions were present upon both sides. The liver was in a cirrhotic condition. Both kidneys were movable. The upper third of the left kidney and the supra-renal capsule were filled to extreme distension with a soft, white and solid purulent matter. The bladder was incised and found containing a very small quantity of normal looking urine. If the damage is slight, the symptoms may pass off and the patient appear seemingly recovered, while in reality the injury is gradually merging itself into a new condition.

It is to be remembered that not infrequently a nephritis, a pyelo-nephritis, a nephritic or peri-nephritic abscess result from such injuries. If the damage is severe the prognosis is always bad, the patient may either succumb to shock in a few hours, or life may be terminated later on from an excessive hæmorrhage. That the patient may recover even in the severest of these injuries there can be no doubt. Mr. Morris has recorded in proof of this a few striking examples.

There is even upon record a case[1] in which recovery followed a laceration of the kidney and the obliteration of the corresponding ureter, the patient finally dying of a granular degeneration of the opposite kidney. Should the patient, in the event of a severe injury, pass beyond the period for the occurrence of death from shock or hæmorrhage, the end may yet be determined by a peritonitis, or by the destruction of tissues from infiltration, or by the protraction of a suppurative process within or about the kidney or bladder, or lastly by the sudden rupture and discharge of an abscess into the peritoneal cavity.

Again, the prognosis may be rendered unfavorable by the involvement of the other organs within the abdominal cavity. Of these the liver is most frequently injured in connection with a renal lesion. Mr. Morris, who has written thoroughly upon this subject, refers to five dangers to be apprehended soon after the reception of the injury.

"First.—Continuous and excessive extravasation of blood leading to death by syncope within a few hours or a day or two.

"Second.—Peritonitis, either as the direct effect of the violence or the tension and ulceration of the peritoneum due to the accumulation of blood and urine which has been extravasated behind the peritoneum.

"Third.—Inflammation and suppuration of the peri-nephritic tissue, and:

[1] Trans. Path. Soc. London. Vol. xi, page 140.

"Fourth.--Occlusion of the ureter by blood clot and the retention of urine within the cavity of the kidney, and its attendant effects of hydro-nephrosis, pyo-nephrosis, pyelo-nephritis, or renal abscess.

"Fifth.—Simple traumatic nephritis."

Otis[1] has recorded 78 cases of shot injuries of the kidney of which 26 recovered. Of these 26 there were 13 upon the right side, 12 upon the left and one in which this point was omitted. In an injury of the right kidney the liver is frequently implicated, whilst in that of the left we have the spleen, stomach, or ascending colon, which not uncommonly suffer in the same accident. Although the prognosis of a shot injury of the kidney alone is by no means favorable, the gravity is naturally increased by the complication of an injury to one or more of the other abdominal organs. An injury of the urinary duct is justly regarded as a serious accident, necessitating in the majority of instances a removal of the organ.

Where the injury is not accompanied with too much laceration recovery may occur for a time, only to be succeeded by a stricture of this duct with an accompanying hydro-nephrosis and destruction of the organ.

Treatment.—The treatment of these injuries naturally varies with the character of the lesion. The most pertinent question which addresses itself to the judgment of the surgeon is the determination of the opportune moment when active interference is demanded. In some, the boldest measures are indicated from the very onset of the injury, while in others complete recovery occurs from a conservative or purely medical line of treatment. The fulfillment of this can only be hoped from a careful knowledge of the symptoms and a very close study of the progress of the case. Even with all this, the course, and symptoms are frequently so vague that in spite of the most careful attention, the ripest opportunity is frequently lost and the organ which was within our efforts is not only lost, but the case often terminates in the death of the individual.

For the sake of clinical reference the treatment is best divided into that of the contusions and lacerations, that of the shot and stab injuries, that of the injuries of the duct, and lastly the treatment of the conditions consecutive to the injury. Contusions and lacerations.

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[1] Medical and Surgical History of the War of the Rebellion. Second surgica volume.

In this variety the imperative indication is the enjoinment of absolute rest in bed. To still further fulfill this demand and for the relief of the pain, the administration of opium should be employed. The bowels should be somewhat constipated and if moved, this should be accomplished by means of a bland enema. In order to loosen the solid residue which tends to increase the vermicular motion and favor the dislodgment of a clot, the food should partake of the nature of a light and a liquid character. All stimulants and substances that are likely to increase the action of the kidneys should be carefully avoided. For the arrest of the hæmorrhage, various remedies have been urged, prominent among which might be mentioned such drugs as ergot, iron, gallic acid, alum, acetate of lead and opium.

But at best, it seems that very little can be expected from these, for if the hæmorrhage is severe enough to be of sufficient note, such drugs can hardly be hoped to supply the want. On the contrary, if it is slight, the hæmorrhage can be expected to be arrested by an absolute quiet, secured through the opium or the use of a full dose of ergot internally, or ergotine sub-cutaneously may also contribute to this end. If any decided benefit is to be derived from any of these it can best be expected from the opium and ergot.

In addition to these, venesection has been recommended in certain strong and healthy individuals with the hope of lessening the blood pressure and diminishing the danger of a rupture into the peritoneal cavity. Locally, the strapping of the affected side and the application of ice externally are to be remembered as adjuvants in securing an immobility of the injured side and in assisting the control of the hæmorrhage. In those cases that are marked with a transient collapse, slight hæmaturia, a limited degree of pain, with a slight area of dullness and with practically little or no fulness, the surgeon can be content with such steps as the careful regulation of the diet, the immobilization of the injured side through the application of adhesive strips applied from the spine to the linea alba, the observance of perfect quiet in bed assisted by the administration of opiates and the checking of the hæmaturia by means of the application of ice externally, and the use of ergot and morphine internally.

An attempt can be made through this line of treatment to create a favorable termination, the surgeon in the meantime holding himself in readiness to assume a more active rôle upon the appearance of any untoward symptom. Should, however, the case be one marked with a notable degree of collapse, persistent or an exaggerated hæmaturia with a distinct fullness in the loin and a considerable area of dulness, it becomes the surgeon's imperative duty to, as promptly as is consistent, explore the injured region. Should the laceration not be too extensive, as for instance a complete division of the organ, an attempt should be made for its preservation. With this end in view, the surrounding region should carefully be freed of all blood clots and cleansed by a thorough irrigation with a sublimate or Thiersch's solution. As for the rent in the kidney, this should be carefully and thoroughly tamponed, together with the surrounding space and, if needbe, the external wound with sublimated or iodoformized gauze.

This can be allowed to remain until all danger of hæmorrhage is past, or until indications arise requiring an earlier removal, the tampon being renewed as often as the urgency of the case may demand. Should the kidney be completely severed, or severely lacerated with several deep fissures, or in a softened and broken down state, nephrectomy is the only alternative. But as already mentioned, it is a very delicate question for decision, to recognize those cases which demand immediate interference, those which require no interference, and those in which operative measures are required secondarily for the relief of the condition, or the correction of a process consecutive to the injury. The exploratory incision, not only affords an accurate means of diagnosis, but allows a more rational plan of treatment, besides affording an easy exit for any extravasated urine and the removal of any clots.

Gunshot injuries of the kidneys are justly to be regarded as serious accidents. This is dependent upon the profuse hæmorrhage which attends these cases and upon the frequency with which they are accompanied by lesions of other abdominal organs.

The means of controlling the hæmorrhage which has always been an important question in the treatment of these cases, has been enlarged upon in these experiments.

For the purpose of management these injuries have been divided into four classes:

First.—Those in which the injury amounts to a superficial laceration, the missile grazing the kidney and carrying with it a portion of its structure, with a remaining surface not unlike in appearance to that of a granulating wound. In these the hæmorrhage is dependent upon the number of vessels exposed and is not infrequently of a considerable amount. A second variety, which amounts to simply a perforation, with little or no appreciable loss of structure. Here the passage usually contracts until it is smaller than the ball itself. This variety is, by far, the safest in character and the most amenable to treatment. A third variety in which the puncture is attended with a loss of kidney structure. In these the wound of entrance is of the size of the ball, whilst that of exit is quite large and attended with the destruction of a portion of the kidney.

Lastly, a fourth class in which the kidney is lacerated beyond redemption or in which the renal artery or a large branch of the same either within or external to the kidney is ruptured.

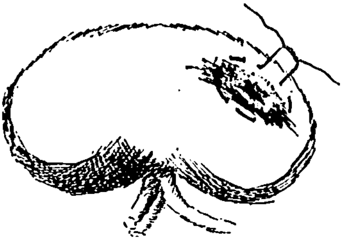

FIG. 1. "Purse-string" suture applied to a gun-shot perforation.

In this class, the extirpation of the organ usually becomes the only alternative. Again, the missile may hopelessly injure either the pelvis or ureter. If the injury of the pelvis is created by a small sized ball, an attempt may still be made to preserve the organ, but where the pelvis is considerably lacerated, or the ureter severely wounded, nephrectomy is the most effectual means of dealing with these cases. Although, even a large branch of the renal artery be divided an effort may still be made to save the organ. The first step in the treatment of any of these, is the establishment of the positive existence of an injury and for this end the recognized rule is to be remembered, that apart from the most exceptional instances exploratory laparotomy should be performed.

The aseptic nature of gunshot wounds in external regions, has long since been pointed out by Bergmann, Esmarch and others, and, acting under the impression that the same would be true as regards such wounds within cavities, experiments were made with the intention of demonstrating this and the establishment of operative measures for their treatment based upon this principle. At first such wounds as are depicted in the second class were treated by transverse sutures over the orifice of the wound, in various directions. Although the results were entirely satisfactory as regards the recovery, this was finally replaced by a "purse-string suture," which has for it the advantages of being easier and more readily applied, in being less liable to tear, and, lastly, in its remote relations to the raw edges of the wound which are thus drawn together in their original condition.

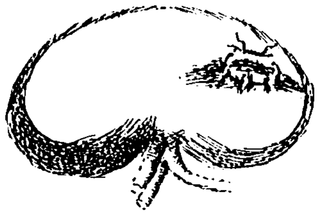

FIG. 2. Gun-shot perforation sealed by a "purse-string" suture.

In applying this suture, as well as in all operative procedures upon the kidneys, care should be observed to preserve the capsule and circum-renal structures which contribute so largely to the strength of the purchase. Where, in a deficiency, or an absence of these, strength is desirable, the stitches can be introduced deeper into the medullary portion, which through its extra quantity of connective tissue, affords a stronger grasp for the stitches.

The orifice thus closed, is securely sealed against hæmorrhage, organization soon follows, which leads to an early and definitive healing. In those injuries of the first class, the hæmorrhage is usually severe. Resection was practiced in some of the experiments for the control of this. The "purse-string suture" applied about 1 centimeter from the edge was successfully tried in smaller wounds and finally likewise adopted in wounds of a larger size. Thus treated, the hæmorrhage promptly ceased, the uneven granular surface was absorbed, leaving behind a smooth, depressed scar of the former lesion. Where the wounded area is unusually large the compression

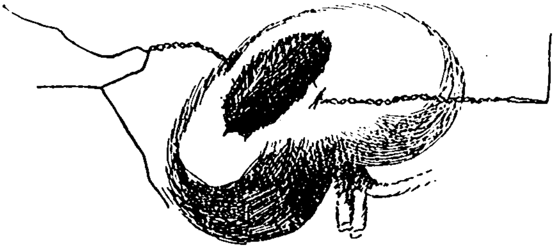

FIG. 3. Introduction of a twisted, double suture for the control of hæmorrhage by means of a double "purse-string" contraction.

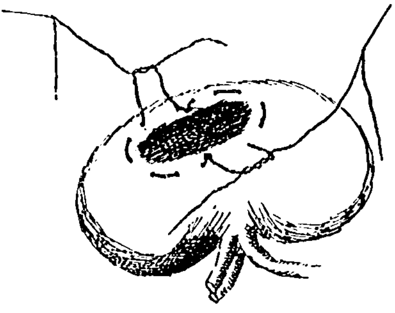

FIG. 4. Showing the application of a double "purse-string" suture for the arrest of hæmorrhage in large superficial gun-shot wounds.

obtained through a single suture is occasionally insufficient. In such instances, the surface is divided into halves and each half separately constricted by means of a suture proper to itself. Should a rebellious vessel still escape compression, this can be secured by a separate stitch introduced for this purpose after the manner of transfixion. This measure can be supplimented with the sear of a Paquelin cautery. The value of this, however, can hardly extend beyond the arrest of an oozing, which is, as a rule, easily controlled by means of the suture.

In those injuries that are characterized with a small wound of entrance, while that of exit is large and marked by a loss of structure, there are two procedures open, the choice of which being largely dependent upon the location of the injury. When the wound is near, or upon the external border, a resection of the entire injury is perhaps the safest and most feasible measure. Should the wound, upon the other hand, be located near the center of the organ the application of a "purse-string suture" to both openings, or the smaller opening may be sutured while the larger is tamponed with sublimate or iodoform gauze and drained through a lumbar incision. Where resection becomes necessary the triangle which is removed should include only the necessary structure and if possible should reach short of the pelvis of the organ. The observance of this practically excludes the dangers of fistulæ and the extravasation of urine. In bringing together the divided surfaces, the entire wound from top to bottom should be united by means of deep interrupted stitches of chromicized cat-gut or silk introduced about 2 or 3 centimeters from the edge, while the superficial edges are

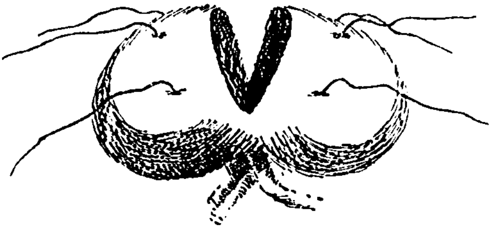

FIG. 5. Introduction of stitches for the closure of the deeper portion of a resection.

opposed by another row of sutures. This can be still further secured by suturing over the divided edge the capsule and circum-renal structure.

Although if the pelvis is laid bare, it should be thoroughly irrigated and freed of all clots before closure of the wound is undertaken. For the control of the most troublesome obstacle in operations upon the kidney the author has devised a clamp for the compression of the renal artery, with the hope of securing a bloodless, or almost bloodless operation. In stab injuries of this organ, the external wound, if necessary, should be enlarged and the exact character of the renal injury determined. If the wound is such that it will admit of an easy apposition, and from the nature of its production the surgeon feels safe as to its aseptic nature, it should be closed just as though it was a simple incision for the purpose of exploration. Or, the closure can be preceded by an irrigation of the wound with a sublimate solution, 1 x 2500.

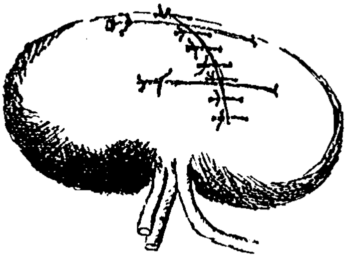

FIG. 6. The method of closing resections and deep exploratory incisions.

If it is evident that for some reason these measures cannot be fulfilled, the surgeon has left, as a last resort, the tamponade and drainage through the loin. Penetrating wounds involving the pelvis should be closed by means of a single or double row of sutures. For injuries of the ureter, unless singularly slight, nephrectomy seems the only alternative, for even though union should result, the dangers of a stricture with the subsequent risk of a hydronephrosis and destruction of the kidney are not to be lost sight of.[1] Injuries of the kidney are frequently attended with secondary complications which require separate interference for their correction. Among these, a very common accident is the accumulation of blood-clots within the bladder.

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[1] Nussbaum has successfully resected a portion of this duct for a wound of the same during an ovariotomy. Surgery of the Kidneys —J. Knowsley Thornton.

Generally, when hemorrhage occurs into the bladder it is promptly evacuated, but occasionally the blood coagulates and not infrequently gives rise to a considerable annoyance. Should the coagulation amount to a few small clots they seldom give rise to any trouble, as the urine exerts a solvent influence thereupon and favors their removal.

Should this be insufficient, the bladder should be thoroughly washed with a mild solution of boric acid, and, if necessary, an evacuating apparatus (Bigelow's) employed for the removal of the clots. Where these measures fail, cystotomy should be performed without further delay. Another common attendant upon these injuries is the extravasation of blood, or urine, or both into the surrounding structures. Although the occurrence of the former is not necessarily dependent upon an injury of this organ, for hæmatomas of considerable size have resulted from the rupture of muscles in this region, or from anastomoses between external and internal arteries, or lastly, from an aneurism of some intra-abdominal artery. Moreover, it is not always an easy matter to discriminate between the extravasation of blood and urine and where there is a perceptible fullness or swelling between either of these, and the swelling caused by an enlargement of the kidney itself. For the discrimination of these, Rayer has suggested the point, that extra-renal extravasation is, as a rule, not as distinct in its outline as in a fullness dependent upon intra-renal extravasation. This, however, is an exceedingly fine discrimination, and in real practice is often quite difficult to execute. The effusion may occur rapidly, as from the rupture of a large vessel, and with the usual signs of a severe hemorrhage.

Frequently it assumes an enormous size, dissecting away the peritoneum, permeating the surrounding structures, and occasionally finding its way along the Psoas and Iliacus muscles into the groin.

Where the diffused hæmatoma is of a rather slow origin, its detection and differentiation is fraught with some difficulty. It may remain unabsorbed, or it may pass through a process of absorption and disappear, or, finally, it may break down and become converted into a nephritic or perinephritic abscess. The course of these extravasations should be carefully guarded, lest they break down and suppurate, bursting finally into the general peritoneal cavity, or dissecting up the neighboring muscles, or burrowing along the Psoas muscle finally to open spontaneously in the groin, or thigh. Probatory punctures with a strictly aseptic aspirating needle should be repeatedly made in different directions. At the appearance of the slightest evidence of pus, early incision through the loin and drainage should be resorted to.

Closely allied to the foregoing is the extravasation of urine. The manner of its distribution, the nature of its production and the obscurity of the symptoms not infrequently make it a difficult matter at times to discriminate between these two conditions. Like the former, its origin may be either of a rapid formation or its growth may be extended over several weeks ere sufficient signs or fullness are present to excite suspicions of an extravasation.

The extravasation may become partly or entirely absorbed, it may excite inflammation and suppuration of the surrounding structures leading to an abscess, which may follow the same course as mentioned in the preceding complication, or it may become incapsulated within a boundary of inflammatory formation producing a pseudo-hydronephrosis.

The infiltrated urine may become mixed with pus, or, as in Mr. Barker's case, concretions of a phosphatic nature may be formed within the sac. The behavior of tissues when infiltrated with urine has been, to say the least, a most interesting subject. In some, the normal urine has excited an intense inflammatory action, ending in suppuration and destruction of the tissues, while on the contrary there is ample evidence of the harmless nature of this fluid, at least under certain circumstances. The experiments of Simon[1] in this direction have conclusively indicated this. •

In short, the experiments have demonstrated that normal acid urine is readily absorbed when injected into the tissues in from a dram to a pound quantities; that urine, more or less ammoniacal or containing pus, is capable of producing a progressive inflammation of the tissues and a gangrenous condition of the skin. He has further added clinically to the strength of those experiments by using for the sponging of wounds in certain plastic operations, urine in place of water, obtaining, notwithstanding this, primary union in every instance. This author is inclined to the belief that the evil effects of the normal acid urine are not due to its direct action, but rather to an interference with the nutrition of the structures which it causes by separating the muscles with its presence in the intermuscular spaces and by elevation of the skin from its underlying bed, thus seriously compromising the nutrition.

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[1] *Ueber die Einwirkung des Urins und Speichels auf die nachte d. i. nicht mit Epithel bekleideten Gewebe v.* Prof. G. Simon, Heidelberg. *Deutsche Klinik.* April, 1869. Nr. 15.

Furthermore, we have the experience of Thornton,[1] which speaks in a similar tone. During a difficult ovariotomy this operator cut the left ureter, which accident was only discovered the following day. Meanwhile the urine continued to flow into the peritoneal cavity, finally making its exit through the drainage tube, saturating the dressings. Although this had been going on for twenty-four hours the peritoneum was not even red. The case recovered soon after a nephrectomy.

When the presence of extravasation is established, it should be promptly relieved for the protection of the surrounding structures. For the fulfilment of this measure, we have the choice of three procedures:

First.—The simple aspiration, repeated if necessary, has in a number of instances been attended with success. Where the sac continues to refill, incision and drainage is indicated. Should the condition continue, dependent upon a stubborn fistula from the pelvis or a severe wound of the kidney, or the ureter, nephrectomy is in most instances the proper step for its relief.

Another complication of note is the appearance of peritonitis. This may occur primarily from the injury itself, or, it may follow secondarily upon some operative measure. The fact of its occurrence, however, can only be regarded as a logical proof of the presence of some condition which requires an active interference. In nearly all of the penetrating and many of the non-penetrating wounds exploratory incision is indicated and carried into effect. In the excepted cases, unless the condition is incompatible with such a step, the appearance of peritoneal symptoms should demand an early exploration.

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[1] J. K. Thornton, Internat. Med. Cong. Rep., 1884. Vol. II.

Where the peritonitis follows secondarily to an abdominal section, made for the repair of such an injury, the use of salines should be employed. For the fulfillment of this end a variety of salines are at hand, none, perhaps, acting with as much certainty and satisfaction as the magnesium powder (oxide) administered in a carbonated beverage.

Should the use of these fail in favorably influencing the peritoneal reaction, an exploration is in order, unless an attending circumstance contra-indicates this step. Apart from these, occasionally there occurs a nephritic or perinephritic abscess, a traumatic nephritis, a pyonephrosis or hydronephrosis, or a host of other sequelæ and complications which more properly deserve an undivided consideration.

EXPERIMENTAL OBSERVATIONS UPON INJURIES OF THE KIDNEY.

EXPERIMENT 1. Aug. 28. Small size dog. Weight 5.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball penetrated the kidney transversely, midway between the external and internal border, near the center of the viscus. The wound of entrance was small and closed by sealing over the orifice with silk. This procedure effectually arrested the hemorrhage from this opening. The wound of exit, however was large and could not be subjected to this treatment. In lieu of this, triangular excision of a portion including the lacerated defect, was resorted to.

The cut surfaces, which bled freely, were each covered with strips of omentum, and the walls brought together by deep and superficial interrupted sutures.

This approximation required a few additional sutures at the inner angle before the hemorrhage ceased.

Given 4 Cc. Magendie's Sol. and removed.

Aug. 29. Walks with unsteady gait and refuses food.

Aug. 30. P. M. Very weak. Died this afternoon. Wound of entrance closed and of an apparently promising appearance. The resection and some distance beyond in a softened and broken down condition. Death from the effects of traumatism.

EXPERIMENT 2. Aug. 28. Small size dog. Weight 7 kilograms. Kidney exposed and shot with a Flobert from a S. & W. pistol. The ball grazed the external border of kidney, creating a wound of about 1 Cm. deep and about 4 Cms. in circumference.

The lesion was treated by excising a triangular portion of the organ which included the entire wounded surface. The fresh surfaces were brought together by deep and superficial sutures which completely arrested the hemorrhage.

Given 4 Cc. Magendie's Sol. hypodermically.

Aug. 29. Very feeble, refuses food.

Aug. 30. Walks about, takes food and suffers great thirst.

Sept. 8. Apparently recovered. The animal was now subjected to a removal of the uninjured kidney.

Sept. 9. Refuses food, but seems otherwise very little affected by second operation.

Sept. 10. Takes food freely and appears lively.

Sept. 11. Same.

Oct. 18. The animal appears in perfect spirits. Has apparently gained in weight and shows no signs of the former operations. Sacrificed for the examination of the remaining kidney.

P. M. Kidney diminished in size. The site of resection marked by a slight omental adhesion and the edges rounded and partly gaping. Union of the surfaces being only partial and no fistula.

Experiment 3. Sept. 19. Large size dog. Weight 21 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, the ball passing transversely through the center of the organ.

The orifices, which were small, were closed by a row of sutures.

In closing the wound upon the external surface, the circumrenal fat was utilized and drawn over the wound more securely closing the orifice. This effectually arrested the hemorrhage.

Given 4 Cc. Magendie's Sol. and removed.

Sept. 20. Refuses both food and water, but walks about and otherwise appears unaffected.

Sept. 21. Takes food and appears lively.

Sept. 22. Same.

Oct. 28. Killed to obtain the specimen.

P. M. Kidney in a firm condition, marked only by two small depressed scars.

Experiment 4. Sept. 22. Small size dog. Weight, 10 kilograms. Kidney exposed, and shot with a .22 ball from a S. & W. pistol. The ball passed directly through the long axis of the organ. Both openings were closed by silk sutures, which arrested the hemorrhage. Given 4 Cc. of Magendie's Sol. and removed.

Sept. 23. Drinks water freely and took a small portion of raw meat.

Sept. 24. Died towards evening.

P. M. Cavity contained about 200 Cc. of bloody fluid of a somewhat purulent character. Feeble adhesions between the intestines and omentum. External appearance of the wound unchanged. Upon section the track was found filled with a perfectly clean clot. Death from acute sepsis.

EXPERIMENT 5. Sept. 22. Small size dog. Weight, 6.5 kilograms. Kidney exposed and shot with a Flobert from a S. &. W. pistol. The surface of the ball had been cut with a knife, giving it an uneven appearance. The ball passed directly through the long axis of the organ, creating at its entrance a small opening marked by several diverging fissures.

The wound of exit was very much lacerated and attended with a loss of kidney structure. The wound of entrance was closed with silk sutures, and that of exit was carefully trimmed, removing the prominent lacerated edges. The hemorrhage from this opening was partly arrested by means of interrupted stitches applied in different directions and partly by the implantation of the omentum. Given 4 Cc. Magendie's Sol. and removed.

Sept. 23. Refuses food and appears feeble.

Sept. 24. Takes a small quantity of food.

Sept. 25. Improving.

Sept. 26. Appears lively and eats with good appetite.

Oct. 5. Nephrectomy was practiced upon the uninjured kidney.

Oct. 6. Took a few ounces of milk.

Oct. 7. Appears hearty.

Nov. 23. Killed to obtain specimen.

P. M. Kidney firmly united and omental implantation strongly adherent.

EXPERIMENT 6. Sept. 29. Large size dog. Weight, 17 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed transversely through the kidney near the centre. The wound of entrance was small and closed with a continuous silk suture. The wound of exit was at least four times larger than the wound of entrance.

The closure of this was unsuccessfully attempted with interrupted silk sutures. The hemorrhage was finally arrested from this source by means of a purse suture. The contused tissue, which slightly projected, was carefully trimmed away and the organ returned. The cavity was thoroughly cleansed and closed.

Given 4 Cc. of Magendie's Sol. and removed.

Sept. 30. Walks about. Drinks large quantities of water, but takes sparingly of finely-chopped meat.

Sept. 31. Appears hearty. Eats and drinks freely.

Nov. 3. Perfectly recovered. Nephrectomy was practiced upon the uninjured kidney.

Nov. 4. Refuses food and water.

Nov. 5. Takes both food and water.

Dec. 8. Lively. Eats and drinks heartily. Killed to obtain the injured kidney.

P. M. Small cicatrix marking the wound of entrance. Upon the opposite side there was an appreciable depression with a few adhesions.

Experiment 7. Oct. 19. Medium size dog. Weight 15.5 kilograms. Kidney exposed and shot with .22 ball from a S. & W. pistol. The missile shattered the lateral aspect and then passed through the kidney beneath a bridge of renal tissue. The whole track was resected, leaving a little over two-thirds of the kidney behind. Almost perfect apposition was obtained by a series of deep and superficial stitches. The kidney was thoroughly irrigated and returned. The cavity was washed and carefully sponged to free it from clots. The shock that followed this operation was quite marked and dependent largely upon the excessive hemorrhage. Given 4 Cc. of Magendie's Solution, hypodermically, and a rectal injection consisting of 300 Cc. of a warm solution of chloride of sodium, with 60 Cc. of dilute alcohol. The deep stitches in this experiment consisted of catgut that had been immersed in the tincture of chloride of iron and then dipped in the U. S. P. alcohol. Rallied from shock in about two hours.

Oct. 20. Refuses food and lays quiet.

Oct. 21. Remains in one place. Took a few ounces of milk and water.

Oct. 22. Took a small quantity of raw meat and water.

Oct. 23. Same.

Nov. 2. Has been progressing nicely. Presents a somewhat emaciated appearance, but eats well and appears lively.

Nov. 10. Nephrectomy was practiced upon the remaining kidney.

Nov. 11. Refuses food and water.

Nov. 12. Improved.

Nov. 13. Eats and drinks.

Nov. 16. Refuses food.

Nov. 17. Eats heartily again. Continued thus, being fed entirely upon a diet of raw beef, till Dec. 26.

Dec. 27. Refuses to eat and drink. Very emaciated and suffering from a diarrhœa.

Dec. 28. Refuses food. Diarrhœa increased. Stools streaked with blood. Animal quite weak.

Dec. 29. Condition exaggerated.

Dec. 30. Found dead. The animal in a very much emaciated condition. The bony prominences presented a raw and somewhat ulcerated appearance. These raw surfaces at times would heal, but only to break open and recur.

P. M. The animal had already been dead eighteen hours. The intestines only slightly congested here and there. The spleen small and quite hard. The kidney diminished in size, marked upon its external surface by two shallow fissures; upon its internal surface by an omental adhesion and a depressed cicatrix marked by several diverging cicatricial lines. At the upper extremity of the kidney there was adherent a globular body of about 5 Cm. in circumference, which from all appearance, seemed to be the supra-renal capsules, filled with a soft but thick, purulent matter. The kidney was firmly united and in a good condition. The superficial suture, which was a continuous one, still imbedded. The deep sutures were absent. The remainder of this kidney represented about five-eighths of its secreting surface. The spleen upon section revealed a small abscess cavity. Unfortunately, other organs not examined. Death very likely from the suppurative process, favored, in all probability, by a renal insufficiency.

EXPERIMENT 8. Oct. 19. Medium size dog. Weight 18 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol.

The ball took a superficial course, passing along the upper surface, tearing away a portion of the kidney, which left a lacerated bleeding surface. Resection was practiced, removing not quite as much of the kidney structure as in the foregoing experiment. The deeper parts were apposed by ferrated catgut and the superficial edges by means ot silk. The organ was thoroughly irrigated and returned.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 20. Refuses milk and water and remains quietly in one place.

Oct. 21. Takes a small quantity of food and lies very quietly.

Oct. 22. Same.

Oct. 23. Great thirst. Refuses food.

Oct. 24. Found dead.

P. M. Cavity contained 700 Cc. sanguino-purulent fluid, no adhesions. Kidney softened and broken down. Death from extravasation of urine and septic matter into the peritoneal cavity.

EXPERIMENT 9. Oct. 10. Medium size dog. Weight 14.5 kilograms. Kidney exposed and shot with a .22 ball obliquely through its long axis. The would of entrance was small and closed with a double row of silk. The wound of exit was large and in a lacerated condition. Closure of this was accomplished partly by the purse suture and partly by omental implantation.

Kidney sutured and given 4 Cc. of Magendie's Sol.

Oct. 11. Refuses food, but otherwise appears strong.

Oct. 12. Takes food and appears lively.

Oct. 13. Same.

Nov. 16. The dog appears lively, eats well and apparently perfectly recovered.

Nephrectomy was practiced upon the uninjured kidney. In the removal of the kidney the ligature slipped and a profuse hemorrhage ensued. It was only secured after enlarging the wound. Cavity was carefully cleansed and closed.

Given 4 Cc. Magendie's Sol. and removed.

Nov. 17. Walking about. Refuses food, but very thirsty.

Nov. 18. Same.

Nov. 19. Found dead.

P. M. Cavity contained 70 Cc. of sanguino-purulent fluid and a few feeble adhesions. The opposite kidney was found perfectly healed with implanted omentum adherent, together with a coil of intestine. Death from acute septic peritonitis.

EXPERIMENT 10. Nov. 1. Medium size dog. Weight 17 kilograms. Kidney exposed and shot with a .22 ball through its long axis.

The wound of entrance was closed with a double row of silk sutures.

The wound of exit was partly sealed with a double row of sutures, assisted by an implantation of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 2. Refuses food and water.

Nov. 3. Takes a few pieces of raw meat and water.

Nov. 5. Refuses food.

Nov. 6. Anæsthetized and lumbar wound, which was gaping and of a necrotic appearance, carefully washed out, trimmed and enlarged. The kidney drawn into view and found very slightly gaping, with the omentum adherent. The omentum carefully removed for inspection and closure of the deeper parts. The kidney was thoroughly irrigated and returned. Stimulated with hypodermics of whisky.

Nov. 7. Found dead.

P. M. Cavity clean. A few feeble adhesions. Death from septic peritonitis.

Experiment 11. Dec. 28. Large size dog. Weight 26.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, creating a superficial laceration upon the surface of the organ. The bleeding surface was thoroughly irrigated and a purse suture applied. This effectually arrested all hemorrhage.

Given 4 Cc. of Magendie's Solution and removed.

Dec. 29. Up; appears lively and takes a quantity of raw meat.

Dec. 30. Same.

Jan. 20. Killed to examine specimen.

External wound almost entirely healed. The injured surface presented a depressed appearance with no diminution in the size of the kidney.

Experiment 12. Dec. 12. Large size dog. Weight 23 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol, the ball passing obliquely through the organ. Various sutures applied in different directions, but failed to arrest the hemorrhage. The kidney was in such a state of degeneration that no purchase could be obtained by any suture. Nephrectomy seemed the only alternative and was performed.

Dec. 13. Walks unsteadily and refuses food.

Dec. 14. Same.

Dec. 15. Takes a small quantity of milk.

Dec. 16. Presents a drowsy appearance. Slight diarrhœa.

Dec. 18. Diarrhœa increased. Indifferent to food. Expression stupid and very much emaciated in appearance.

Dec. 20. Condition about the same. Diarrhœa increased and streaked with blood.

Jan. 5. Found dead. From the last to the present date, the animal gradually lost ground. The appetite became more affected, the form more emaciated and the diarrhœa increased. The expression throughout was one of utter apathy.

P. M. Cavity clean. The remaining kidney enlarged, hyperæmic, granular and degenerated. The small intestines of an anæmic appearance, marked by hyperæmic patches. Death from nephritis.

EXPERIMENT 13. Dec. 31. Large size dog. Weight 19 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed obliquely from the external to the internal border, severing a large branch of the renal artery and completely shattering the pelvis of the kidney.

The wound of entrance was sealed with a purse suture. Resection was unsuccessfully attempted for the wound of exit. Nephrectomy was indicated and performed.

Jan. 1. Up, and walking about. Takes a small quantity of meat.

Jan. 18. Recovered from the nephrectomy. Eats and drinks heartily. External wound almost healed. Nephrectomy was again performed upon the remaining kidney at 8 P. M.

Jan. 19. Refuses food and water. Remains quietly in the same place.

Jan. 20. No change.

Jan. 21. Same.

Jan. 22. Died sometime between 7 and 9 P. M.

P. M. Cavity clean. The intestinal mucous surface apparently normal.

Before death the animal appeared dull and indifferent.

EXPERIMENT 14. Nov. 13. Small size dog. Weight 6.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed through the long axis of the organ. The wound of entrance closed with a silk suture. That of exit closed in a similar manner and reinforced by a covering of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Nov. 14. Refuses food. Takes a small amount of water.

Nov. 15. Eats and drinks.

Nov. 16. Same.

Dec. 21. Recovered and subjected to another experimental operation.

EXPERIMENT 15. Jan. 10. Medium size dog. Weight 8 kilograms. Kidney exposed and compressed in two contiguous spots with blunt forceps. The instrument left a deep, blanched spot, which soon swelled up and became cyanosed for some distance beyond. Kidney returned.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Up and takes food.

Jan. 12. Seems very little affected by the injury.

Jan. 21. Apparently recovered. Eats and drinks heartily. Killed to examine the specimen.

P. M. Kidney depressed in the spots corresponded to the injury. Evidences of cicatricial tissue around the seat of the former lesion.

Experiment 16. Jan. 10. Medium size dog. Weight 8.5 kilograms. Kidney exposed and lacerated by bending it up on itself. This produced a lacerated wound marked by a considerable degree of contusion. The laceration, which was double, measured about 3 Cm. in length, and about 1 Cm. in depth. Hemorrhage resulted to a notable degree. The surface was thoroughly irrigated and the edges of the laceration brought together by deep sutures of silk. Kidney was carefully returned.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Refuses food. Walks about.
Jan. 12. Same.
Jan. 13. Eats a few pieces of raw meat.
Jan. 14. Eats sparingly. Appears apathetic.
Jan. 15. Refuses food.
Jan. 16. Refuses food.
Jan. 18. Eats and drinks.
Jan. 19. Same.
Jan. 22. Found dead.

P. M. Omentum and spleen adherent. The laceration gaping and covered with a yellowish suppurating surface.

Sutures still imbedded. A small abscess was found communicating with the laceration.

Death from exposure.

Experiment 17. Jan. 10. Medium size dog. Weight 9 kilograms. Kidney exposed and compressed with the same instrument that was used in the previous experiment, but with almost double the amount of pressure. The kidney enlarged and rapidly assumed a bluish color for some distance beyond the lesions.

Given 4 Cc. of Magendie's Sol. and removed.

Jan. 11. Takes a few pieces of raw meat.
Jan. 12. Same.
Jan. 13. Very much improved—appetite better.
Jan. 22. Appears recovered. Eats and drinks heartily and is apparently recovered.

Disappeared.

Experiment 18. Small size dog. Weight 6.5 kilograms. Kidney exposed and the clamp applied to the renal artery. An oval piece measuring 7 Cm. in circumference and 1 Cm. in depth was carefully sliced off. The raw surface was surrounded by a purse-suture introduced about 1 Cm. from its edge. The clamp was released and hemorrhage in one or two spots at the lower half of the raw surface returned. An unsuccessful attempt was made to arrest the hemorrhage from these points by the sear of a Paquelin cautery. This arrested the hemorrhage in all but one small artery. The hemorrhage from this was finally arrested by a second suture introduced through the middle of the wounded surface, and brought around its lower border in such a manner as to include the lower half of the wound. Cavity was sponged.

Given 4 Cc. Magendie's Sol. and removed.

Jan. 11. Refuses food. Takes a few ounces of water.

Jan. 12. Eats and drinks.

Jan. 13. Same.

Jan. 27. Lively. Eats and drinks heartily.

Killed for further examination.

P. M. The wounded kidney was covered with adherent omentum and spleen in a very firm manner.

EXPERIMENT 19. Jan. 16. Small size dog. Weight 7 kilograms. Kidney exposed and severely compressed in three places. The organ very soon assumed twice its original size, became dark-blue in color and fluctuant to the touch. In this state the organ was returned.

Given 4 Cc. of Magendie's Sol.

Jan. 17. Appears feeble. Refuses food.

Jan. 18. Indifferent. Refuses food.

Jan. 19. Eats a few pieces of raw meat.

P. M. Dead. Kidney still marked with a deep blue, contused spot. The end was largely determined by exposure.

EXPERIMENT 20. Oct. 17. Medium size dog. Weight, 16.5 kilograms. Kidney exposed and shot with a .22 ball from a S. & W. pistol. The ball passed transversely through the medullary portion of the organ. The wound of entrance was small and the hemorrhage arrested therefrom by means of a silk suture. The wound of exit was large and stellate in appearance. Transverse suturing for the arrest of hemorrhage was unsuccessfully attempted. The purse suture was then applied and accomplished the desired end. This was reinforced by the implantation of omentum.

Given 4 Cc. of Magendie's Sol. and removed.

Oct. 18. Appetite fair. Appears lively.

Oct. 19. The same.

Nov. 20. Nephrectomy was practised upon the uninjured kidney.

Nov. 21. Refuses food.

Nov. 22. Eats and drinks.

Nov. 23. Same.

Jan. 3. Perfectly recovered. Killed for further examination.

P. M. The wound firmly repaired and apparently unchanged in size. Omentum adherent.

EXPERIMENT 21. Nov. 19. Small size dog. Weight, 4 kilograms. Kidney exposed and incised along its external border. This incision reached to a point about midway between the external border and edge of the pelvis. This was closed by a continuous silk suture. Good apposition and perfect hæmostasis was obtained.

Given 2 Cc. of Magendie's Sol. and removed.

Nov. 20. Up and appears lively. Eats hearty and is apparently unaffected by the operation.

Nov. 22. Same.

Dec. 26. Sacrificed for further examination.

P. M. Wound nicely united. Stitch visible beneath a layer of exudate.

EXPERIMENT 22. July 9. Small size dog. Weight, 7.5 kilograms. Anæsthetized. Spot selected in the linea alba shaved and disinfected. Six hypodermics of recently drawn urine were injected through this spot into the abdominal cavity.

Given 2 Cc. of Magendie's Sol. and allowed to come from under the anæsthetic. The animal showed evidences of uncomfort.

July 10. The posterior extremities weak and unsteady. This, passed away during the day.

July 11. Appears lively and takes food freely.

July 20. Recovered. Sacrificed for examination.

P. M. No signs of any adhesions visible.

EXPERIMENT 23. July 12. Small size dog. Weight, 5.5 kilograms. Kidney exposed and a triangular piece resected measuring 2 Cm. at its base and reaching almost into the pelvis. The surfaces were brought together by three deep interrupted catgut sutures and the edges approximated by a running silk stitch. The capsule was drawn over the raw edges and united by fine catgut sutures.

Given 2 Cc. of Magendie's Sol. and removed.

July 13. Appears fresh and at noon drank a small quantity of milk.

July 14. Appears lively and drinks milk freely.

July 28. Nephrectomy was practised upon the opposite kidney.

July 29. Refuses food.

July 30. Eats and drinks.

Aug. 5. Appetite good and appears hearty.

Sept. 2. Killed for further examination.

P. M. Kidney firmly united. Diminished considerably in size. Omentum adherent.

EXPERIMENT 24. Jan. 18. Medium size dog. Weight 17 kilograms. The left ureter was exposed through a lumbar incision and severely compressed with an ordinary hæmostatic forceps in a number of contiguous places.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Up; eats and drinks and appears, if at all, very slightly affected.

Jan. 20. Same. Continued thus till Feb. 10th, when he made his escape.

EXPERIMENT 25. Jan. 18. Medium size dog. Weight 15 kilograms. Left ureter exposed through a lumbar incision and incised for a distance of 6 Cm.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Refuses food and water.

Jan. 20. Same.

Jan. 21. Found dead.

P. M. Adhesions among the intestines and omentum. Here and there were scattered solid flakes of a yellow-purulent substance. Cavity contained 415 Cc. of bloody urine. Death from sepsis.

EXPERIMENT 26. Jan. 18. Small size dog. Weight 14 kilograms. Left ureter exposed and divided about 8 Cm. from the kidney. It was then noticed that the animal was pregnant and apparently near the full time.

Given 2 Cc. of Magendie's Sol.

Jan. 19. Found dead.

P. M. The abdominal cavity contained a large number of blood clots. There was but a small amount of fluid present. The tubes which contained the product of conception were empty.

Death was perhaps hastened by the absorption of the urine and the interference with pregnancy.

(*To be continued.*)